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ARTIFICIAL INTELLIGENCE-BASED ALGORITHMS FOR EARLY DETECTION OF HEART DISEASES

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Abstract

Cardiovascular diseases are among the leading causes of morbidity and mortality worldwide, making early diagnosis a critical factor in reducing complications and improving patient outcomes. This article explores artificial intelligence-based algorithms for the early detection of heart diseases. Machine learning and deep learning techniques are analyzed using electrocardiogram (ECG) signals, clinical indicators, and laboratory data. The findings indicate that artificial intelligence significantly enhances diagnostic accuracy and reliability while supporting clinical decision-making. The proposed algorithmic approach enables timely diagnosis, risk stratification, and the development of personalized treatment strategies, thereby improving the overall quality of healthcare services.

Keywords

Artificial intelligence; heart diseases; early diagnosis; electrocardiogram (ECG); machine learning; deep learning; medical data analysis.

Introduction

Heart diseases remain a major global health concern due to their high prevalence and increasing mortality rates. Traditional diagnostic methods often rely on clinical symptoms that typically appear at advanced stages of disease progression, limiting the effectiveness of preventive interventions. In recent years, artificial intelligence (AI) has emerged as a powerful tool in medical diagnostics, offering new opportunities for early detection and prediction of cardiovascular diseases.

Advances in machine learning and deep learning have enabled the analysis of complex and high-dimensional medical data, including ECG signals and electronic health records. The integration of AI technologies into clinical practice has the potential to transform conventional diagnostic workflows and improve patient outcomes through early intervention.

Materials and Methods

This study is based on a comprehensive review and analytical synthesis of recent scientific publications related to artificial intelligence applications in cardiovascular diagnostics. Various machine learning algorithms, including Logistic Regression, Random Forest, and Support Vector Machine, were examined for their effectiveness in early heart disease detection.

In addition, deep learning models such as Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks were analyzed due to their ability to process time-

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series data and extract complex patterns from ECG signals. Model performance was evaluated using commonly applied metrics, including accuracy, sensitivity, specificity, and area under the ROC curve.

Results and Discussion

Algorithmic Framework

The proposed artificial intelligence-based framework consists of several sequential stages: medical data acquisition, preprocessing, feature extraction, model training, and risk classification. The integration of ECG signals with clinical and laboratory data enhances the robustness and reliability of early diagnosis.

Clinical Significance of AI-Based Algorithms

AI-driven diagnostic systems provide valuable support to clinicians by identifying high-risk patients at an early stage. Such systems reduce diagnostic uncertainty, facilitate preventive interventions, and enable individualized treatment planning.

Comparison of Machine Learning and Deep Learning Models

Machine learning models demonstrate stable performance and high interpretability, making them suitable for clinical environments with limited datasets. In contrast, deep learning models show superior diagnostic accuracy when trained on large-scale datasets. CNN architectures effectively capture morphological features of ECG signals, while LSTM models analyze temporal dependencies in cardiac activity.

Limitations and Future Perspectives

Despite their advantages, AI-based diagnostic systems face challenges including data quality issues, limited availability of annotated datasets, and concerns related to data privacy. Future research should focus on explainable artificial intelligence and real-time diagnostic systems.

Conclusion

Artificial intelligence-based algorithms demonstrate substantial potential for the early detection of heart diseases. Their integration into clinical practice improves diagnostic accuracy, supports clinical decision-making, and enables early preventive interventions. Ultimately, the adoption of AI-driven diagnostic systems can contribute to reducing cardiovascular mortality and improving the effectiveness of healthcare systems.

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